

January 6, 1959

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Hycon Manufacturing Company
Pasadena, California

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Dear [REDACTED]

We have reviewed your letter of 12 December 1958 with considerable attention. We agree that the recommendation you have made, one of the several alternatives proposed by [REDACTED] at our meeting of December 10, 1958, has considerable merit in that it would provide an unbiased evaluation of the present state of the development of the C system. If the Photographic Laboratories of Wright Field have the personnel and funds available to conduct such an investigation and the desire to do so, they would learn much about the system and the many developments which it embodies.

I feel that you and your organization should receive a more detailed analysis of the circumstances as we see them, which have led to the present termination of activity on this project, so I take this opportunity of laying them before you.

There are two requirements which the C system must satisfy in order for it to be operationally acceptable. These are, first, that it take pictures of such quality as to make the disadvantages of complexity of operation and its small angular field acceptable and, second, that these pictures must be of the proper objects. So far, with the exception of one or two flight tests, we all have confined our attention to the problems of the first sort, that of picture quality. In this system, as in any air-borne camera, there are only three features of the system which affect the quality. These in order of importance are, first, that the system operate in a mechanical manner which permits the taking of pictures at all. The shutter must open and the film must transport at the proper time. Second, a variety of optical conditions must be satisfied. These include the fact that optical elements themselves must be of proper design and of adequate accuracy in manufacture. In addition, they must be mechanically positioned so as to be centered and aligned. All of these conditions are of no avail if the focus is not in a proper position with relation to the film. Third, there must be less than an acceptable motion between the image and the film during the exposure. This last requirement is the one that has led us to such complications as stabilization, image motion compensation and the serious attack on the problems of vibration for the C system. Its long focal length has made its sensitivity to these effects very great.

The design and development philosophy which we have tried to apply to this system consists of the following steps:

1. An analysis of the requirements in each of the critical areas imposed upon that area by the eventual picture quality we wished to achieve. It is unfortunate that as the program has progressed we have been forced by circumstances to lower our sights from the very high standards with which we started. I feel this is unfortunate for even today I am

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not aware of any basic limitation which need demand a retreat from our original objective of 60 lines per millimeter for high contrast objects in the air. We have shown by bench tests that the optics as now manufactured when enveloped in a proper environment could produce the results envisioned in the optical design. This has not been an easy accomplishment for it was punctuated by many delays and setbacks.

2. After the analysis of requirements, each component and subsystem was to be designed and manufactured to meet its individual specification.
3. Each component and subsystem would then be subject to such tests and investigations as to determine whether its performance was within the necessary limits.
4. The system as a whole would then be assembled and given as thorough testing as ground equipment availability would permit.
5. After evidence of satisfactory operation was obtained we would flight test. It is to be expected that flight testing would produce evidence of malfunction not uncovered in the ground testing because of our limited ability to reproduce with accuracy, flight conditions. Further, the most sensitive indication of proper performance will always be pictures taken in the air. They and only they will tell us when everything is working correctly. Unfortunately, they are very poor indications of what is wrong when things are wrong. I now feel that the greatest single lesson that I have learned from this experience is to be a lot surer of proper operation on the ground before attempting to flight test under conditions of the sort we have faced. The conditions I refer to are those of limited flight instrumentation, unattended and unobserved operation, and very limited control of operating conditions.

Let me review the recent programs from our point of view with these five steps in mind. First, flight tests were undertaken in late 1956 and early 1957. These tests taught us three important lessons. Although the optical system performance was considerably below its ultimate, it was good enough to provide an insight into the problems of internally produced vibrations as well as vibrations arising in the vehicle. In addition, we became acutely aware of the problems of achieving and holding focus. These were not unexpected problems for their magnitude had been realized and discussed on many occasions during the design of the system. The surprise feature of the result was that we had not arrived at adequate solutions. Finally, we were subject to actual failures in operation. At this point, it seems in retrospect, the engineers at grips with the individual problems confined their attention too much to the task of overcoming the breakdowns rather than taking the broader view of achieving satisfactory operation in a quantitative sense as well.

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As these flight tests progressed on into the spring of 1957, the problems of proper image motion compensation became increasingly demanding of attention. During the early summer of 1957, the optics were improved and installed in the hope that improved optical performance would permit a clearer evaluation of the factors limiting resolution in the air. At this time there was such pressure for flight tests that again insufficient ground testing was undertaken. Thus, the flight tests of August through November of 1957 simply demonstrated that: focus, principally adjustment and temperature compensation; vibration, both internal and vehicle; and inadequate stabilization including image motion compensation--all of which could have been thoroughly investigated on the ground before flight testing--were limiting the performance to that well below the capabilities of even a degraded optical system. The flight tests did, however, show up some areas where the reliability of some components and subsystems was less than desired.

With the availability of a set of quite good optics, an attempt was made to install these in an improved and more up-to-date system--improved and up to date in the sense of greater reliability, but without much real improvement toward the problems discussed above. The installation attempted on the West Coast did not prove to be satisfactory, so, the system was sent East. This transfer of activity was undertaken for two reasons. The first, mentioned above, concerned the installation of the optics while the second was to give us an opportunity to examine the magnitude of the remaining problems of temperature, vibration and stabilization. Our objective was to study the methods and approaches for combating these degrading influences then incorporated in the design. We were then to decide whether these were adequate in principle and only deficient in performance, or whether the approaches themselves were at fault. After considerable and careful study, we arrived at the first of the two possible conclusions; that of proper approach, but inadequate performance. Even in the light of all subsequent events, we still believe this conclusion to be correct.

We, together with yourselves, proposed and subsequently embarked on a program to accomplish a considerable number of changes and improvements during the midsummer of 1958. These were aimed at improving reliability as a necessary first step, but with great emphasis on proper performance as well. The last part of June and the first week of July were to be spent in complete ground tests of the modified system with test flights scheduled in the latter part of July and early in August. It would appear now that inadequate ground testing was undertaken in spite of the fact that flight tests were not started on schedule because of delays with the vehicle. Flight tests initiated to establish proper focus simply showed up improper operation or failure in shutters, stabilization or IMC. By the end of September, after nine-flights--none of which could be said to be free of some malfunction, which either stopped operation or produced image motion--it seemed time to review our progress.

At a meeting at WPAFB on 2 October, a return to the basic philosophy was recommended by us and concurred in by our customer. This program consisted of component and subsystem testing and modification to bring individual performance up to requirement, ground testing of the complete system to examine it for proper

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overall performance and reliability, and then, if all seemed satisfactory, to flight test. All agreed that mid-November for completion of ground tests was an obtainable objective.

Some troubles of an optical nature prevented testing of the optics at high resolution. These difficulties have been traced to the collimator, but they prevented performance of high resolution optical tests in conjunction with complete ground system tests. In addition to these delays, various problems with components delayed the system ground tests until 5 December. The first test resulted in three mechanical failures of a minor sort, but two were the same as one which had occurred during previous flight tests and which makes the system incapable of satisfactory operation. Considerable useful data was recorded during this test, however, while the system was in operation.

At a general meeting on 10 December, the statement was made that the failure of the previous ground test was understood and could be fixed and that the next ground test, if one could be run, would be satisfactory in all respects. Such a test was run on 11 December. It was interrupted by the same failure as was the previous test. Certain test instrumentation failed to give useful results but since no changes had been made to the system, other than the correction of the faulty part, the records of the previous test were examined to evaluate performance. In addition to the failure referred to before, IMC was found to be variable in rate, not only from exposure to exposure but with considerable drift over a long period as well, and various undesirable vibration characteristics of the scanning flat were observed. Vibration and stabilization conditions could not be observed because of lack of data. Thus, it seemed to us that we were not ready for flight tests. Such tests at this time could only show results little, if any, better than on the many previous occasions even if there were no failures.

We reported our observations to our customer on the evening of 11 December and offered to place at his disposal an enlarged group of engineers to help in the solution of the remaining problems directed toward ground tests at a later date after we were convinced that the various components and subsystems were performing their functions in an acceptable fashion. When such ground tests indicated good probability of proper performance in flight, flight test would be undertaken. We felt that no additional funds would be required.

After considerable discussion, the customer decided that his time had run out and the effort was better used elsewhere. His decision has been reported to you so that all proper steps may be taken to bring the activity to a proper conclusion.

This development has been a great disappointment to me, as I know it is to you and your people. The disappointment is not only in the fact that we have not been able to provide a proper and satisfactory device from a technical standpoint, in spite of the long period and the great support from our customer which we have enjoyed but, as well, for the fact that our two organizations have not found a way of working together toward the common goal which would produce a satisfactory product.

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I am sure that we have both learned several valuable lessons in the way in which an activity of this sort must be undertaken and carried out. It would seem that we must be satisfied with this result at least for the present.

We are working at this time on recommendations as to the disposition of the equipment. As soon as we learn the desires of the customer we will inform you as to such disposition.

Sincerely yours,

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Vice President
Reconnaissance

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CC: Mr [REDACTED]

Attachment III

TERMS AND CONDITIONS

I. Our proposal is based on the award of a Cost-Plus-Fixed-Fee Contract with the understanding that the cost principles set forth in Revision 50 of the Armed Services Procurement Regulations will apply. In addition, the following terms and conditions apply.

A. The following shall be considered allowable items of cost on the performance of this contract.

1. General research as a component part of the Contractor's G & A expense in accordance with the cost principles delineated in Revision 50 to Section 15 of the ASPR.
2. Expenditures by the Contractor for transportation of the personnel directly engaged in the performance of the work hereunder, plus reasonable actual subsistence expenses.
3. Overtime wages, including premium, and shift premium.
4. Progress payments to subcontractors performing work under this contract on a fixed-price basis.
5. Special Costs - The cost of guard services, rental of a station wagon, private telephone lines, receptionist-switchboard operator and a maintenance man in connection with the operation of the secure area of the Contractor's Post Road Plant shall be direct costs under this contract. Rental on the leased Post Road Plant shall be treated as an indirect cost.
6. Extended travel compensation in accordance with Section 805-8 of our Policy and Procedure Manual. Copies of this policy are attached for your information. This is the same policy presently recognized in Part III (11) of Contract LW-473, Amendment No. 5.

B. The fixed fee shall be paid in monthly installments based on allowable costs incurred by the Contractor and approved by the Contracting Officer computed at the same ratio that the total fixed fee stated herein is to the total estimated cost stated herein, subject, however, to the normal 15% withholding provision on the payment of fee.

II. Our proposal is further based on the following:

A. No-charge usage of facilities under Contract AF 33(600)-28501 and Contract RE-518.

III. All prices for hardware are quoted F.O.B. Norwalk, Connecticut.

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| PERSONNEL | POLICY AND PROCEDURE MANUAL | No. 805-8 Date 12-19-58 Page 1 of 3 New |
| Approved: <i>J.P.D.</i> | Extended Travel Compensation | |

GENERAL:

This policy covers compensation for eligible employees who are required to spend an extended time away from the Norwalk area. Sales personnel are excluded from this policy.

1. CLASSIFICATIONS OF EMPLOYEES:

An employee, to be eligible, must be assigned to one of the following classifications:

- (A) Temporary Duty (Field Status). This will include all employees who make frequent trips of varying duration requiring absence from home.
- (B) Extended Change of Station. This classification includes employees who are assigned to a location away from the Norwalk area for an extended period. For the definition of this policy, the word "extended" shall mean any assignment of six months or longer.

Assignment of an individual to either of the classifications which make him eligible for extended travel compensation will require the approval of the employee's supervisor and cognizant Department Director.

2. ELIGIBILITY FOR EXTENDED TRAVEL COMPENSATION:**Temporary Duty (Field Status)**

An employee shall become eligible for extended travel compensation when he spends a minimum of 35% of his work schedule in any three month period away from the Norwalk area. Eligibility will be determined monthly on the basis of activity during the preceding three months.

Extended Change of Station

Under this provision, an employee becomes eligible for extended travel compensation when he is assigned to a location outside the Norwalk area for a period of six months or longer.

3. EXTENDED TRAVEL COMPENSATION PAYMENT:

Employees eligible for extended travel compensation under the above

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provisions will be compensated in accordance with the following schedule:

TEMPORARY DUTY (Field Status)

- (A) Employees will be reimbursed for actual and reasonable travel expenses in accordance with existing Company policy.
- (B) Employees classified in hourly job classifications will be compensated for overtime for the actual hours worked in accordance with existing policy.
- (C) Hourly employees will be compensated 15% above base rate for domestic service for hours for which they are eligible. The adjustment for overseas service for hourly employees will be 25% above base rate for all eligible hours. Overtime will be computed on base rate, excluding adjustment.
- (D) Salaried employees will be compensated 20% above base rate for domestic service for all time for which they are eligible. The adjustment for overseas service for salaried employees will be 30% above base rate. No payment will be made for overtime unless such overtime is authorized and approved in accordance with Corporate policy.
- (E) The adjustment in compensation will be effective upon the employee's departure from Norwalk.

EXTENDED CHANGE OF STATION

- (A) On an extended change of station assignment a contract will be written with individual employees within the framework of this policy. In instances where circumstances dictate, Division Management may write special contracts beyond the limits established herein.
- (B) Employees will be compensated for expenses on a per diem basis, which will be determined in accordance with Corporate and/or Government policy established in the concerned areas. For required travel (of a non-local nature) away from the regularly assigned base, employees will be compensated for actual and reasonable expenses.
- (C) Employees classified in hourly job classifications will be compensated for overtime for the actual hours worked in accordance with existing policy.

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- (D) Hourly employees will be compensated 25% above base rate for both domestic and overseas assignments for all hours worked when assigned to an extended change of station status. Overtime will be computed on base rate, excluding adjustment.
- (E) Salaried employees will be compensated 30% above base rate for domestic and overseas assignments for all time for which they are eligible. This adjustment for salaried employees is all inclusive, and no payment will be made for overtime unless such overtime is authorized and approved in accordance with Corporate policy.
- (F) In the case of an extended assignment, the employee will be allowed a trip to his home at Company expense every two months. The time and length of the visit to the home area shall be dependent upon the contractual obligation with the customer. This will require prior approval by the employee's Supervisor. Extended travel compensation will not apply during the period employee is in his home area.
- (G) The adjustment in compensation will be effective upon the employee's departure from Norwalk.